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(54) Method of splicing polarization-maintaining optical fibers

Verfahren zum Spleissen von polarisationserhaltenden Glasfasern

Procédé pour l'épissage de fibres optiques à maintien de polarisation

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Description**BACKGROUND OF THE INVENTION****Field of the Invention**

[0001] The present invention relates to a method of fusion-splicing polarization-maintaining optical fibers.

Related Background Art

[0002] Optical fiber splicers has been described in U.S.P. Nos. 4,506,947, 4,690,493, 4,914,797, 5,002,351, 5,011,259, and 5,218,184, and Japanese Patent Laid-Open No. 2-287504.

[0003] EP-A-0 319 041 describes a method and apparatus for fusion-splicing polarization-maintaining optical fibers in which a TV camera is used to observe the optical fibers before splicing. An optical image of the fibers is displayed on a TV monitor, together with a luminance profile of the image.

SUMMARY OF THE INVENTION

[0004] When light is irradiated to two opposing optical fibers from a lateral side, transmitted optical images of the respective fibers can be obtained. These fibers can be aligned by moving them such that the positions of the luminance peaks of the respective transmitted optical images coincide.

[0005] However, when two optical fibers are aligned by setting the positions of their luminance peaks to coincide with each other while visually observing the luminance peaks, the axes of the optical fibers after alignment sometimes do not coincide with each other depending on the individual difference of the operator. When these optical fibers are spliced, the spliced optical fibers are sometimes misaligned from each other by a maximum of about 4°.

[0006] The present invention has been made in view of the above problem, and has as its object to provide a method of fusion-splicing polarization-maintaining optical fibers, wherein the polarization-maintaining optical fibers can be spliced without being comparatively influenced by differences in individual operators. According to this method, the positions of the luminance peaks of the respective optical fibers are displayed on a display in the form of numerical values, and these numerical values are set to be equal to each other, thereby rotationally aligning the optical fibers.

[0007] More specifically, according to the present invention, there is provided a method according to claim 1.

[0008] In the present invention, since the first and second values corresponding to the rotational positions of the fibers are displayed on the display, the rotational positions of the first and second fibers are set to coincide with each other quantitatively. Thus, rotational alignment in fusion splicing of the first and second fibers can

be performed without being influenced by the differences in individual operators. If the distributions of the respective luminances are displayed on the display, the positions of the luminance peaks can be visually set to coincide with each other. The first value can be calculated by obtaining the ratio of a difference between the positions of the first and second luminance peaks to a difference between the positions of the first and third luminance peaks. In this case, the second value can be calculated by obtaining the ratio of a difference between the positions of the fourth and fifth luminance peaks to a difference between the positions of the fourth and sixth luminance peaks.

[0009] The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not to be considered as limiting the present invention.

[0010] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the claims will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS**[0011]**

Fig. 1A shows an apparatus used to perform an embodiment of the present invention;

Fig. 1B shows the mechanical structure of the apparatus shown in Fig. 1A;

Fig. 2 shows two polarization-maintaining optical fibers;

Fig. 3 shows polarization-maintaining optical fibers that oppose each other;

Fig. 4 shows part of the apparatus shown in Fig. 1A;

Fig. 5 shows a CCD solid-state sensing element;

Fig. 6 shows part of the apparatus shown in Fig. 1A;

Fig. 7 shows a display displaying polarization-maintaining optical fibers and numerical values;

Fig. 8 shows part of the apparatus shown in Fig. 1A;

Figs. 9A and 9B are diagrams for explaining how to sense a real image and a mirror image;

Fig. 10 shows a display displaying polarization-maintaining optical fibers and numerical values;

Fig. 11 shows the luminance distribution of a polarization-maintaining optical fiber on the display;

Fig. 12 is a display displaying polarization-maintaining optical fibers and numerical values; and

Fig. 13 is a display displaying polarization-maintaining optical fibers and numerical values.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] A preferred embodiment of the present invention will be described with reference to the accompanying drawings. Note that the same or identical elements are denoted by the same reference numerals, and a repetitive explanation will be omitted.

[0013] Fig. 1A shows an apparatus used to perform this embodiment. Fig. 1B shows the mechanical arrangement of the apparatus shown in Fig. 1A. Figs. 2 to 13 show the arrangement of this apparatus and a polarization-maintaining optical fiber splicing method employing this apparatus.

[0014] The apparatus shown in Figs. 1A and 1B has rest tables 11 and 12 on which a polarization-maintaining optical fiber 1 is set, and rest tables 13 and 14 on which a polarization-maintaining optical fiber 2 is set. The respective rest tables 11 to 14 have V-grooves 11v to 14v. The polarization-maintaining optical fibers 1 and 2 are set in the V-grooves 11v to 14v of these rest tables 11 to 14, as shown in Fig. 1A.

[0015] This apparatus has a light source 3, e.g., a light-emitting diode, a mirror 7, a television camera 4, an image processing unit 5, a liquid crystal display 6, and a pair of discharge electrodes 15a and 15b.

[0016] The television camera 4 and the rest tables 11 to 14 are movable in directions indicated by arrows in Fig. 1A. In the following description, note that X-, Y-, and Z-axes are orthogonal, and a θ direction is defined as rotation about the Z-axis as the rotation axis. The Z-axis coincides with the horizontal axis, and the X-axis coincides with the vertical axis. The V-grooves 11v to 14v of the respective rest tables 11 to 14 extend in the Z-axis direction.

[0017] The rest table 11 is moved by a motor 16 in the X-axis direction. The rest table 12 is moved by a motor 17 in the Z-axis direction. The rest table 13 is moved by a motor 18 in the Y-axis direction. The rest table 14 is moved by a motor 19 in the Z-axis direction. The television camera 4 is moved by a motor 20 in the X-axis direction and by a motor 21 in the Y-axis direction. These motors 16 to 21 are controlled by a controller 22.

[0018] The upper surface of the rest table 12 is covered with the lower surface of a press member 12a. The optical fiber 2 is sandwiched between the rest table 12 and press member 12a and fixed on the rest table 12. The upper surface of the rest table 14 is covered with the lower surface of a press member 14a. The optical fiber 1 is sandwiched between the rest table 14 and press member 14a and fixed on the rest table 14. The rest tables 12 and 14 are rotated in the θ direction by manually rotating manual dials 23 and 24, respectively.

[0019] The discharge electrodes 15a and 15b are arranged to form a space surrounded by the opposite end faces of the rest tables 11 and 13. In other words, the discharge electrodes 15a and 15b are arranged in the vicinities of the end faces of the fibers 1 and 2. The discharge electrodes 15a and 15b are connected to a dis-

charge circuit (high-voltage generating circuit) 25 including a capacitor. When a high voltage is applied across the discharge electrodes 15a and 15b by the discharge circuit 25, electric discharge occurs. The end portions of the fibers 1 and 2 are fused or melted and spliced by this electric discharge.

[0020] This apparatus will be described in more detail.

[0021] Fig. 2 shows the first polarization-maintaining optical fiber 1 having a core 1b and stress applying members 1c in its cladding layer 1a, and the second polarization-maintaining optical fiber 2 having a core 2b and stress applying members 2c in its cladding layer 2a.

[0022] As shown in Fig. 3, the first and second polarization-maintaining optical fibers 1 and 2 are arranged such that their end faces oppose each other.

[0023] As shown in Fig. 4, light is irradiated toward the first and second polarization-maintaining optical fibers 1 and 2 from the LED 3 arranged on a side of the first and second polarization-maintaining optical fibers 1 and 2, and a first transmitted optical image transmitted through the first polarization-maintaining optical fiber 1 and a second transmitted optical image transmitted through the second polarization-maintaining optical fiber 2 are sensed by the television camera 4.

[0024] The television camera 4 consists of a microscope 4a and a CCD camera 4b arranged on the optical axis of the microscope 4a. The CCD camera 4b has a CCD sensing element 40 and a drive circuit 41 for it. Hollow arrows A and B in Fig. 4 respectively indicate the first and second transmitted optical images.

[0025] When the first and second transmitted optical images A and B are sensed by the television camera 4, they are projected on the sensing surface of the CCD sensing element 40 arranged in the CCD camera 4b, as shown in Fig. 5.

[0026] A video signal output from the CCD sensing element 40 includes a luminance signal. As shown in Fig. 6, this video signal is input to the image processing unit 5.

[0027] Based on the video output of the first transmitted optical image A output from the CCD sensing element 40, the image processing unit 5 calculates the positions of the first to third luminance peaks sensed in accordance with the positions of the core 1b and stress applying members 1c of the first polarization-maintaining optical fiber 1. Also, based on the video output of the second transmitted optical image B output from the CCD sensing element 40, the image processing unit 5 calculates the positions of the fourth, fifth, and sixth luminance peaks sensed in accordance with the positions of the core 2b and stress applying members 2c of the second polarization-maintaining optical fiber 2. This will be described in detail later.

[0028] Furthermore, the image processing unit 5 outputs, to the liquid crystal display 6, the first value calculated from the positions of the first, second, and third luminance peaks. The image processing unit 5 also outputs, to the liquid crystal display 6, the second value cal-

culated from the positions of the fourth, fifth, and sixth luminance peaks. Accordingly, the liquid crystal display 6 displays a first value C and a second value D, as shown in Fig. 7.

[0029] The signals output from the image processing unit 5 and corresponding to luminance distributions A1 and B1 of the first and second transmitted optical images A and B are superimposed on the video signals output from the CCD sensing element 40 and corresponding to the first and second transmitted optical images A and B, and resultant signals are input to the liquid crystal display 6. The signals to be input to the display 6 are further superimposed with signals indicating the first and second values output from a character generator arranged in the image processing unit 5. Accordingly, the display 6 displays the first and second transmitted optical images A and B, the luminance distributions A1 and B1, and the first and second values C and D.

[0030] The first and second values C and D respectively correspond to the rotational positions of the first and second fibers 1 and 2. Therefore, the operator moves the first and second polarization-maintaining optical fibers 1 and 2 such that the first and second values C and D displayed on the display 6 are equal, thereby rotationally aligning the first and second polarization-maintaining optical fibers 1 and 2. The fibers 1 and 2 are moved by rotating the corresponding dials.

[0031] After the first and second values C and D are set equal to each other, the polarization-maintaining optical fibers 1 and 2 are fused, thereby splicing the optical fibers 1 and 2 such that their optical axes coincide.

[0032] In this embodiment, the positions of the fibers 1 and 2 can be quantitatively determined by the operator, as described above. Thus, the polarization-maintaining optical fibers 1 and 2 can be spliced without being influenced by the differences in individual operators. The apparatus used to perform this embodiment was fabricated on the experimental basis, and the splicing method in which quantitateness was introduced into alignment was actually experimented. It became obvious that this splicing method could be operated considerably easily when compared to a conventional fiber fusion splicer. The easy operability of this method is obtained since the first and second values C and D are displayed. The improvement in operational efficiency obtained by this value indication is probably based on the human engineering but its detailed analysis is difficult to make theoretically. However, the experiment of the splicing method of this embodiment in which quantitateness was introduced obviously exhibited improvement in easy operability and operational efficiency. The improvement in operational efficiency achieved by employment of the arrangement of this embodiment was not anticipated at all.

[0033] This embodiment will be described in more detail.

[0034] How to move the first and second polarization-maintaining optical fibers 1 and 2 will be described. As

shown in Fig. 3, the first polarization-maintaining optical fiber 1 is moved in the longitudinal direction (Z-axis direction) of the fiber 1, the X direction perpendicular to the Z-axis direction, and the θ direction as rotation about the Z-axis direction as the rotation axis. As shown in Fig. 3, the second polarization-maintaining optical fiber 2 is moved in the longitudinal direction (Z-axis direction) of the fiber 2, the Y-axis direction perpendicular to both the Z- and X-axis directions, and the ϕ direction as rotation about the Z-axis direction as the rotation axis.

[0035] When the fibers 1 and 2 are moved in this manner, they can be moved in the three-dimensional space.

[0036] How to obtain a transmitted optical image will be described in detail.

[0037] As shown in Fig. 4, the first and second transmitted optical images A and B are optical images that are transmitted through the first and second polarization-maintaining optical fibers 1 and 2. When obtaining these optical images, if the microscope 4a (television camera 4) is moved as shown in Fig. 8, transmitted optical images sensed from two directions can be obtained for one polarization-maintaining optical fiber.

[0038] In this arrangement, as shown in Fig. 8, the polarization-maintaining optical fibers 1 and 2 are arranged to extend in a direction perpendicular to the surface of the sheet of the drawing. When the reflecting mirror 7 is used, as shown in Fig. 8, the two transmitted optical images (a real image and a mirror image) from the two directions can be obtained. More specifically, when the LED 3 and microscope 4a are arranged on a side of the polarization-maintaining optical fibers 1 and 2, as shown in Figs. 1A and 8, and the microscope 4a is moved relative to the reflecting mirror 7, the real and mirror images of each of the polarization-maintaining optical fibers 1 and 2 can be caused to be incident on the microscope 4a.

[0039] The microscope 4a is moved by a general electric motor. The moving range of the microscope 4a is limited by limit switches 8a to 8d provided around the microscope 4a.

[0040] When the microscope 4a is arranged at the position of a point P of Fig. 8, a real image can be caused to be incident on the microscope 4a. When the microscope 4a is arranged at the position of a point Q of Fig. 8, a mirror image can be caused to be incident on the microscope 4a.

[0041] Therefore, as shown in Fig. 9A, an optical image AB of light irradiated toward the polarization-maintaining optical fibers 1 and 2 in the X-axis direction and transmitted through the polarization-maintaining optical fibers 1 and 2 is incident on the microscope 4a located at the point P. As shown in Fig. 9B, an optical image AB of light irradiated toward the polarization-maintaining optical fibers 1 and 2 in the Y-axis direction and transmitted through the polarization-maintaining optical fibers 1 and 2 is incident on the microscope 4a located at the point Q.

[0042] To align the polarization-maintaining optical

fibers 1 and 2, while observing the transmitted optical images in the X direction, the optical fibers 1 and 2 are aligned in the X direction by setting the first and second values to be equal such that the positions of the luminance peaks displayed on the display 6 overlap. Thereafter, while observing the transmitted optical images in the Y direction, the optical fibers 1 and 2 are aligned in the Y direction by setting the first and second values to be equal such that the positions of the luminance peaks displayed on the display 6 overlap.

[0043] How to calculate the luminance peak position will be described in detail.

[0044] As shown in Fig. 10, the transmitted optical image A of the polarization-maintaining optical fiber 1 and the transmitted optical image B of the polarization-maintaining optical fiber 2 are displayed on the display 6. A sampling line is set in a direction perpendicular to the longitudinal direction of the transmitted optical image B, and the luminance distribution of the transmitted optical image B on this sampling line is measured. Fig. 11 is a graph for explaining the luminance distribution on the sampling line. As shown in Fig. 11, the luminance on the sampling line has peaks corresponding to the edge of the outer diameter of the fiber, and three peaks corresponding to the core and the stress applying members of the fiber. Since the position of a pixel on the display 6 can be processed in accordance with the address of an image memory in the image processing unit 5, the three luminance peak positions corresponding to the core and stress applying members can be detected by using the image processing unit 5.

[0045] As shown in Fig. 12, the three luminance peaks of the first transmitted optical image A are defined as first, second, and third peaks 1p, 2p, and 3p, and the three luminance peaks of the second transmitted optical image B are defined as fourth, fifth, and sixth peaks 4p, 5p, and 6p, respectively.

[0046] The distance between the first and second peaks 1p and 2p is "a", the distance between the first and third peaks 1p and 3p is "b", the distance between the fourth and fifth peaks 4p and 5p is "c", and the distance between the fourth and sixth peaks 4p and 6p is "d".

[0047] These distances a to d are obtained by processing the luminance distributions of the transmitted optical images A and B in the image processing unit 5, and are displayed on the lower area of the display 6. When these numerical values a to d calculated in the image processing unit 5 are displayed on the display 6, the operator can align the fibers 1 and 2 only by setting these numerical values a to d to satisfy $a : b = c : d$. Although this aligning method is good, the operator must recognize four different values in this case. Thus, to further improve the operational efficiency, a/b and c/d are calculated in the image processing unit 5, and the first and second values C and D obtained by these calculations are displayed on the display 6, as shown in Fig. 13. Then, the number of numerical values the operator

need to recognize can be reduced to two, thus greatly increasing the operational efficiency of the operator.

[0048] After alignment in the X direction is performed in the above manner, alignment in the Y direction is performed in the same manner. Then, the optical axes of the first and second polarization-maintaining optical fibers 1 and 2 coincide with each other. In this embodiment, the first and second values C and D are displayed. However, a difference obtained by subtracting the second value D from the first value C may be displayed on the display 6. Regarding setting of the distances or distances a to d, a may be defined as the distance from the central position of the outer diameter of the polarization-maintaining optical fiber indicated on the left to the upper-side maximum luminance position, b may be defined as the distance from the central position of the outer diameter of the polarization-maintaining optical fiber indicated on the left to the lower-side maximum luminance position, c may be defined as the distance from the central position of the outer diameter of the polarization-maintaining optical fiber indicated on the right to the upper-side maximum luminance position, and d may be defined as the distance from the central position of the outer diameter of the polarization-maintaining optical fiber indicated on the right to the lower-side maximum luminance position. If a sensed optical image is out of focus, a numerical value completely different from that obtained when the optical image is focused will be displayed on the lower portion of the display 6. In this case, the focus is adjusted by changing the focal position of the microscope 4a.

[0049] After the polarization-maintaining optical fibers 1 and 2 are aligned in the above manner, their central cores are aligned. Then, power is supplied to the discharge electrodes 15a and 15b arranged in the vicinities of the end faces of the fibers, thereby fusion-splicing the polarization-maintaining optical fibers 1 and 2.

[0050] As has been described above, according to the present invention, the axes of polarization-maintaining optical fibers can be easily aligned by setting the first and second values displayed on the display to coincide with each other. Since a predetermined quantitative standard can be obtained in alignment of polarization-maintaining optical fibers, the spliced state of polarization-maintaining optical fibers will not differ from one operator to another.

[0051] From the invention thus described, it will be obvious that the invention may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

[0052] The basic Japanese Application No. 247853/1994 filed on October 13, 1994 is hereby referred to.

Claims

1. A method of splicing first and second fibers (1,2) each of which is a polarization-maintaining optical fiber having a core (1b, 2b) and two opposed elongate stress applying members (1c, 2c), comprising the steps of:

arranging the first and second fibers such that the ends thereof oppose each other;
irradiating light on the opposed ends of the first and second fibers so as to transmit the light across and through the end portions of the fibers in a direction perpendicular to the longitudinal direction of each of the fibers, the transmitted light forming first and second images (A, B) of the respective first and second fibers (1, 2);

and

sensing the first and second images with a television camera (4), each of the images having a luminance distribution in a direction perpendicular to the longitudinal direction (Z) of each of the fibers, each of the luminance distributions (A1, B1) having three luminance peaks (1p, 2p, 3p, 4p, 5p, 6p) corresponding to the respective core and the two stress applying members;

the method further comprising the steps of:

(a) obtaining the positions of the luminance peaks by using a signal from said television camera;

(b) displaying on a display (6) first and second numerical values (C, D) respectively calculated from the relative positions of the three peaks of the respective images (A, B), the calculation being identical for each of the respective images;

(c) manually rotating each of the fibers about the longitudinal direction (Z) of each of the fibers so that the first and second values (C, D) become equal, whereby the stress applying members of the two fibers are rotationally aligned; and

(d) splicing the first and second fibers (1, 2) after step (c).

2. A method according to claim 1, further comprising the step of displaying the first and second images (A, B) together with the first and second values (C, D) on the display (6).

3. A method according to claim 1, wherein the first and second numerical values are each calculated from the ratios a/b or c/d , where,

a or c indicates a value corresponding to a distance between the position of the respective central luminance peak corresponding to the core and the position of one of the two respective non-central luminance peaks corresponding to the stress applying members; and b or d indicates a value corresponding to a distance between the position of the respective central luminance peak corresponding to the core and the position of the other respective non-central luminance peak corresponding to the other stress applying member.

Patentansprüche

1. Verfahren zum Spleißen erster und zweiter Fasern (1, 2), von welchen jede eine polarisationserhaltende optische Faser mit einem Kern (1b, 2b) und zwei gegenüberliegenden länglichen spannungsausübenden Elementen (1c, 2c) ist, welches Verfahren die folgenden Schritte aufweist:

Anordnen der ersten und zweiten Fasern so, daß ihre Enden einander gegenüberliegen;
Strahlen von Licht auf die gegenüberliegenden Enden der ersten und zweiten Fasern, um das Licht über und durch die Endteile der Fasern in einer Richtung senkrecht zur Längsrichtung jeder der Fasern zu senden, wobei das gesendete Licht erste und zweite Bilder (A, B) der jeweiligen ersten und zweiten Fasern (1, 2) ausbildet; und

Erfassen der ersten und zweiten Bilder mit einer Fernsehkamera (4), wobei jedes der Bilder eine Luminanzverteilung in einer Richtung senkrecht zur Längsrichtung (Z) jeder der Fasern hat, wobei jede der Luminanzverteilungen (A1, B1) drei Luminanzspitzen (1p, 2p, 3p, 4p, 5p, 6p) entsprechend dem jeweiligen Kern und den zwei spannungsausübenden Elementen hat;

wobei das Verfahren weiterhin die folgenden Schritte aufweist:

(a) Erhalten der Positionen der Luminanzspitzen durch Verwenden eines Signals von der Fernsehkamera;

(b) Anzeigen erster und zweiter numerischer Werte (C, D) auf einer Anzeige (6), die jeweils aus den relativen Positionen der drei Spitzen der jeweiligen Bilder (A, B) berechnet werden, wobei die Berechnung für jedes der jeweiligen Bilder identisch ist;

(c) manuelles Drehen jeder der Fasern um die Längsrichtung (Z) jeder der Fasern, so daß die ersten und zweiten Werte (C, D) gleich werden, wodurch die spannungs-

ausübenden Elemente der zwei Fasern drehend ausgerichtet werden; und
(d) Spleißen der ersten und zweiten Fasern (1, 2) nach dem Schritt (c).

2. Verfahren nach Anspruch 1, das weiterhin den Schritt zum Anzeigen der ersten und zweiten Bilder (A, B) zusammen mit den ersten und zweiten Werten (C, D) auf der Anzeige (6) aufweist.

3. Verfahren nach Anspruch 1, wobei die ersten und zweiten numerischen Werte jeweils aus den Verhältnissen a/b oder c/d berechnet werden, wobei

a oder c einen Wert entsprechend einem Abstand zwischen der Position der jeweiligen zentralen Luminanzspitze entsprechend dem Kern und der Position einer der zwei jeweiligen nicht zentralen Luminanzspitzen entsprechend den spannungsausübenden Elementen anzeigt; und
b oder d einen Wert entsprechend einem Abstand zwischen der Position der jeweiligen zentralen Luminanzspitze entsprechend dem Kern und der Position der anderen jeweiligen nicht zentralen Luminanzspitze entsprechend dem anderen spannungsausübenden Element anzeigt.

Revendications

1. Procédé de raccordement d'une première et d'une deuxième fibres (1, 2) dont chacune est une fibre optique à maintien de polarisation ayant une âme (1b, 2b) et deux organes (1c, 2c) allongés, opposés, d'application d'une contrainte, comprenant les étapes consistant à :

disposer la première et la deuxième fibres de sorte que leurs extrémités soient en opposition l'une par rapport l'autre;
irradier de la lumière sur les extrémités opposées de la première et de la deuxième fibres, de manière à transmettre la lumière en travers et par les parties d'extrémité des fibres, dans une direction perpendiculaire à la direction longitudinale de chacune des fibres, la lumière transmise formant une première et une deuxième images (A, B), respectivement de la première et de la deuxième fibres (1, 2);
et
détecter la première et la deuxième images avec une caméra de télévision (4), chacune des images ayant une distribution de luminance dans une direction perpendiculaire à la direction longitudinale (Z) de chacune des fibres,

chacune des distributions de luminance (A1, B1) présentant trois pics de luminance (1p, 2p, 3p, 4p, 5p, 6p) correspondant à l'âme respective et aux deux organes d'application d'une contrainte; le procédé comprenant de plus les étapes consistant à :

- (a) obtenir les positions des pics de luminance en utilisant un signal de ladite caméra de télévision;
(b) afficher sur un afficheur (6) une première et une deuxième valeurs numériques (C, D) calculées respectivement à partir des positions relatives des trois pics des images respectives (A, B), le calcul étant identique pour chacune des images respectives;
(c) faire tourner manuellement chacune des fibres autour de la direction longitudinale (Z) de chacune des fibres, de sorte que la première et la deuxième valeurs (C, D) deviennent égales, les organes d'application d'une contrainte des deux fibres étant alors alignés sur le plan de la rotation;
(d) raccorder la première et la deuxième fibres (1, 2) après l'étape (c).

2. Procédé suivant la revendication 1, comprenant de plus l'étape consistant à afficher la première et la deuxième images (A, B) conjointement avec la première et la deuxième valeurs (C, D) sur l'afficheur (6).

3. Procédé suivant la revendication 1, dans lequel la première et la deuxième valeurs numériques sont chacune calculées à partir des rapports a/b ou c/d , où,

a ou c indique une valeur correspondant à une distance entre la position du pic de luminance central, respectif, correspondant à l'âme, et la position de l'un des deux pics de luminance non centraux, respectifs, correspondant aux organes d'application d'une contrainte; et
b ou d indique une valeur correspondant à une distance entre la position du pic de luminance central, respectif, correspondant à l'âme, et la position de l'autre pic de luminance non central, respectif, correspondant à l'autre organe d'application d'une contrainte.

Fig. 1A

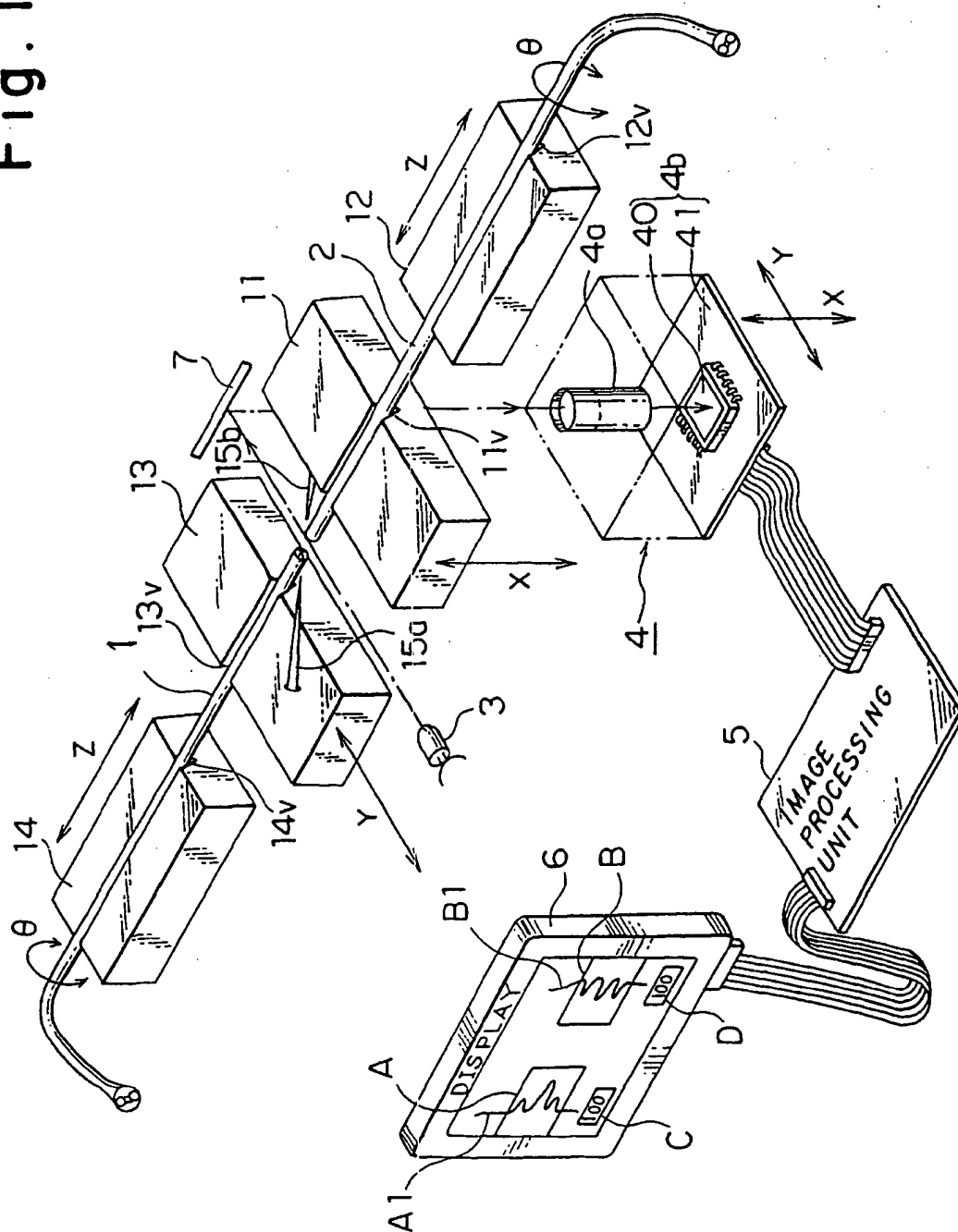


Fig. 1B

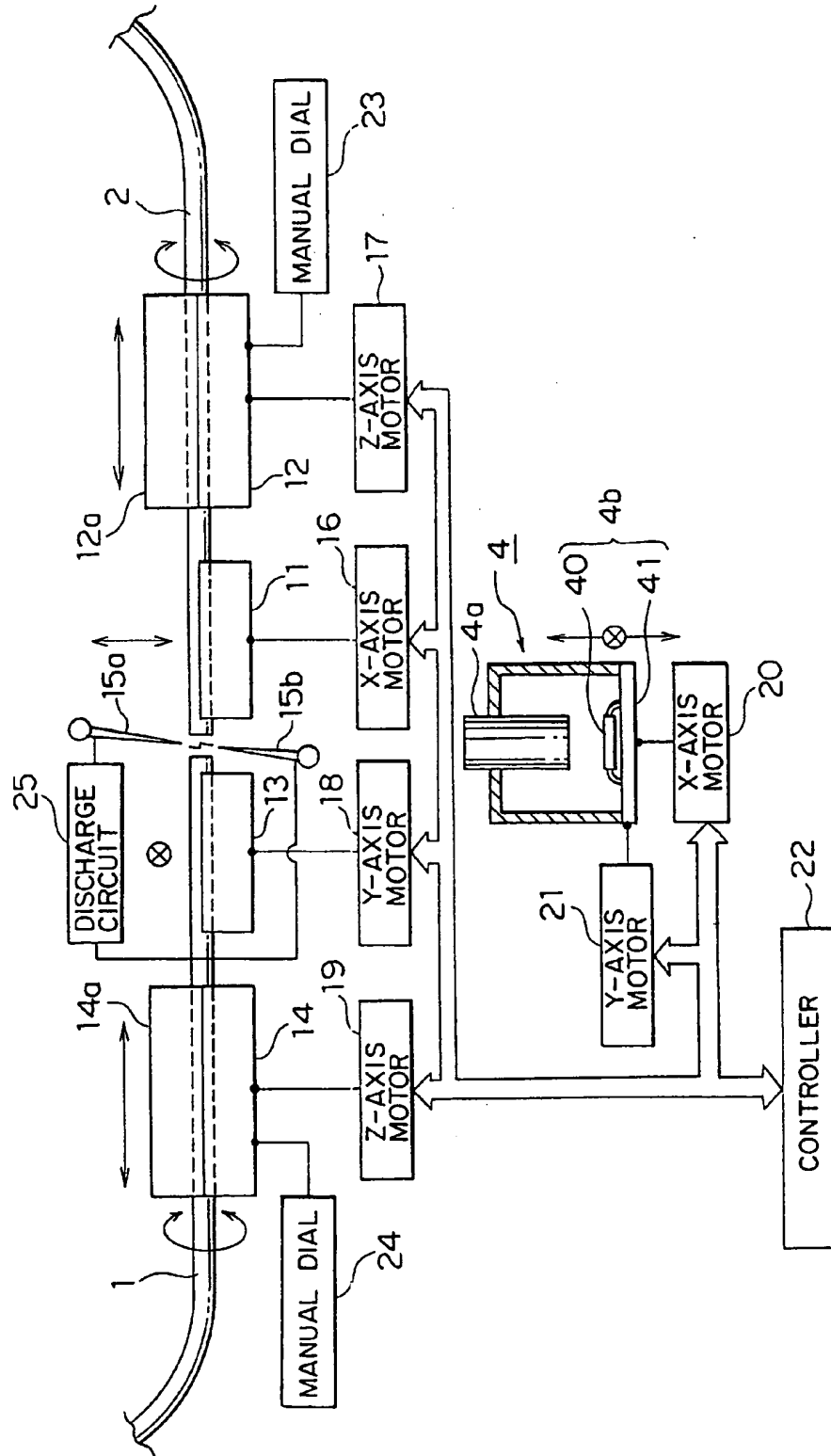


Fig. 2

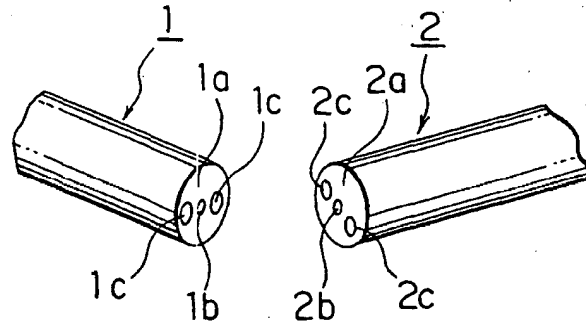


Fig. 3

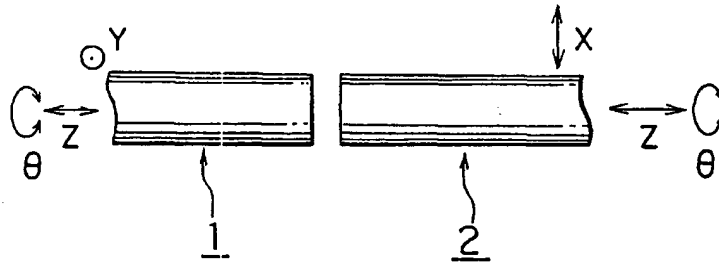


Fig. 4

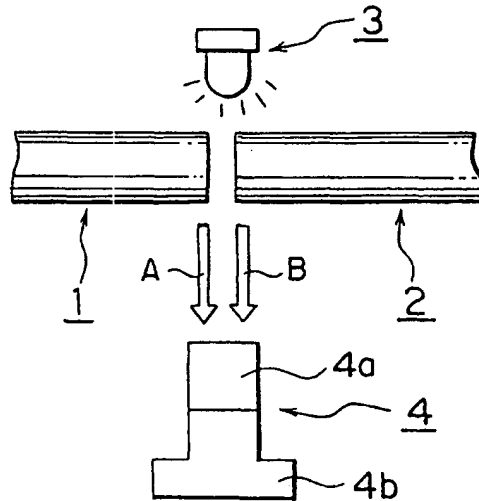


Fig. 5

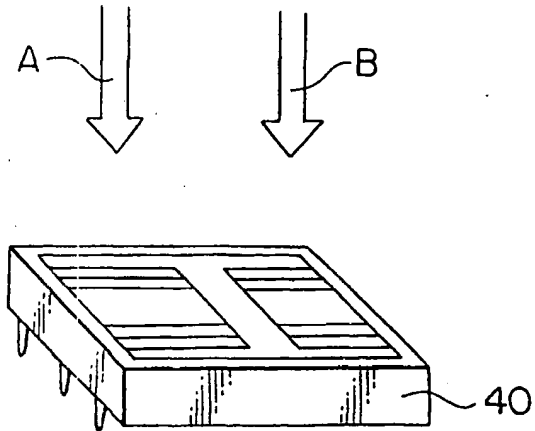


Fig. 6

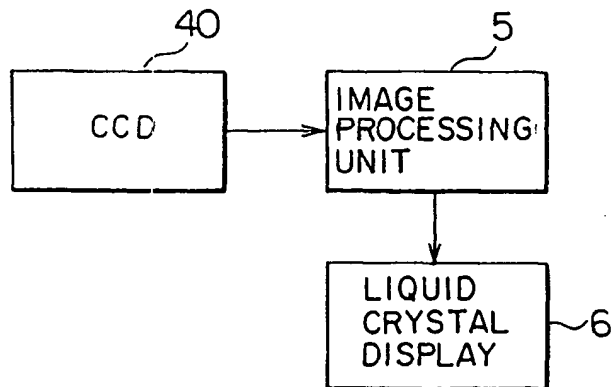


Fig. 7

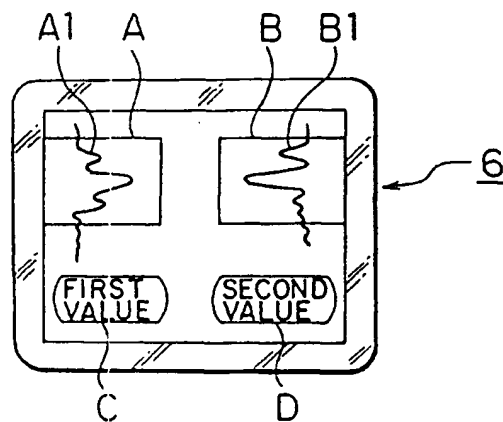


Fig. 8

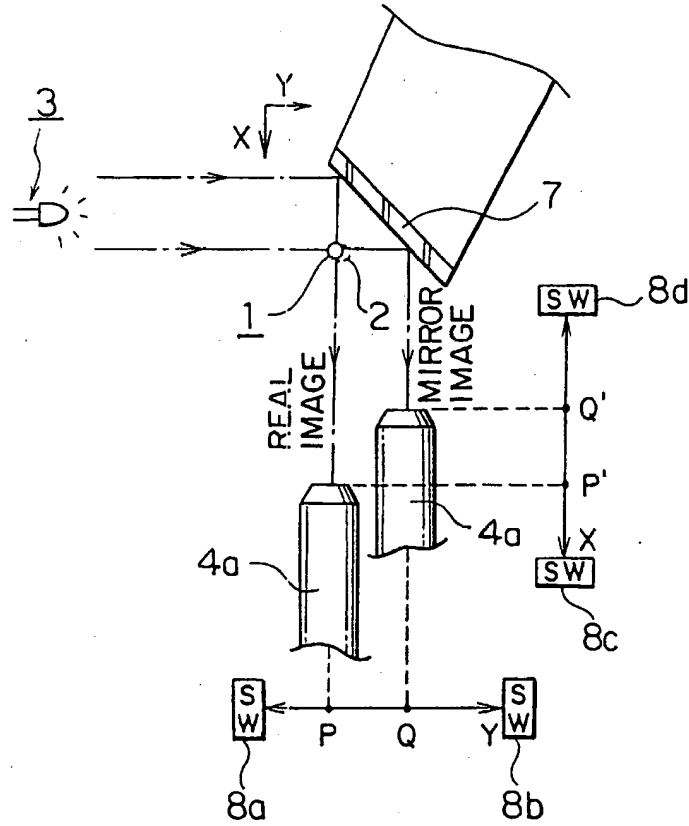


Fig. 9A

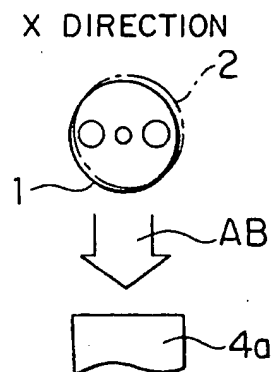


Fig. 9B

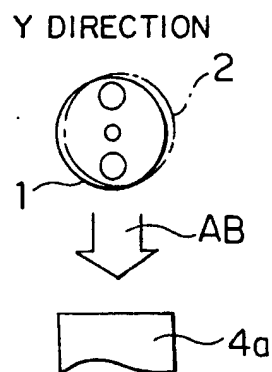


Fig. 10

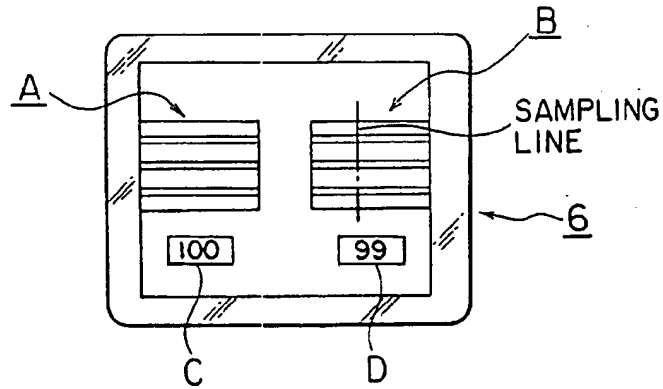


Fig. 11

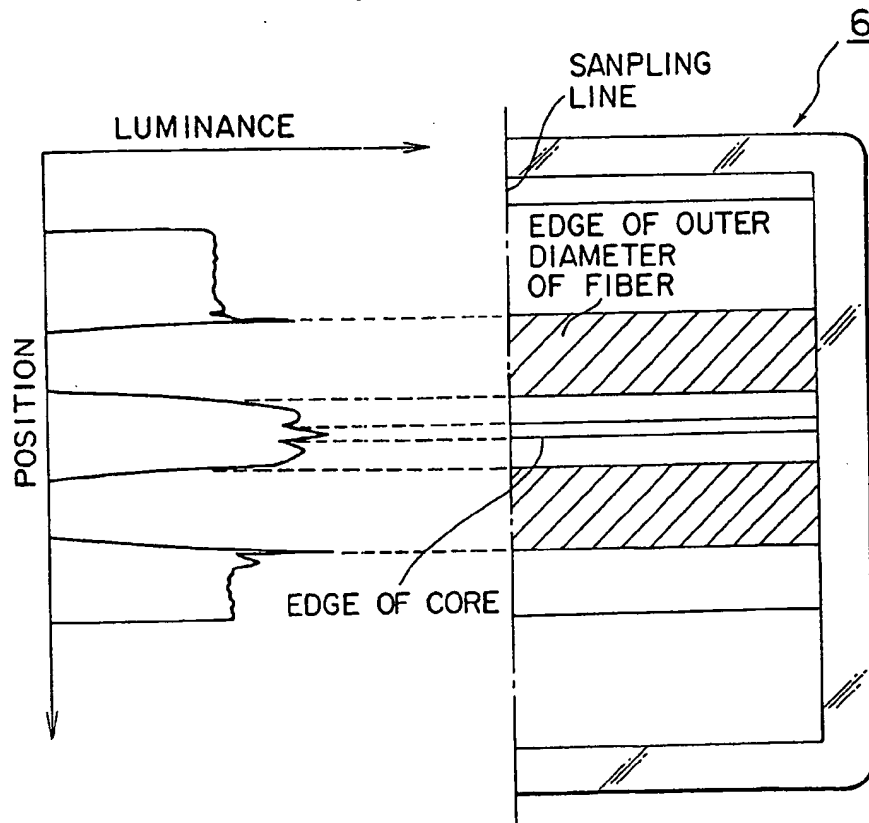


Fig. 12

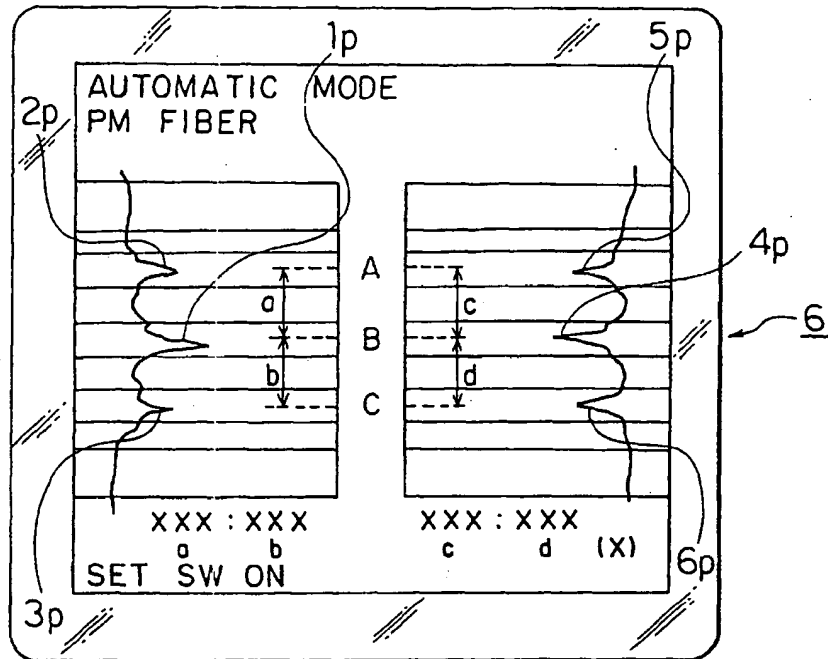


Fig. 13

